Space Weather Technical Forecast

Issued on Tuesday, 04 July 2023 at 01:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active fluence slowly declining. R1/R2 Radio Blackouts likely. Chance of S1/proton storms throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M1.3 flare, peaking at 03/0653 UTC, originating from AR3358 in the southeast quadrant. There are currently seven sunspot regions on the visible disc, five of which are numbered. AR3354 in the northwest remains the largest and most magnetically complex region on the visible disc, which contains a weak delta spot, although this is becoming more difficult to access as it approaches the northwest limb. This region has already produced an X1 flare back on July 02, although no CME was evident following this event. AR3358 and AR3359 in the southeast did show some slight growth, where AR3359 was showing a weak delta spot in its trailing portion, but has since separated from the penumbral area and is now classified as a Dso/Beta-Gamma configuration. The remaining regions on the disc are all relatively small and stable. No Earth-directed CMEs were observed during this period.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, indicates the waning weak connection to CH18/+, with wind speeds declining from around 430 km/s to 380 km/s. The density was below average (<5 ppcc). The IMF was weak throughout, peaking at 7 nT, while the north-south component varied weakly, with a slight bias to positive. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV) was at mainly high levels, peaking at 3083pfu at 03/1515 UTC. The 24-hour integrated fluence has been on a slight rising trend just above the Active threshold throughout. A fluence of 1.45e8 was recorded at 04/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is likely, with a slight chance of further X-class flares. The risk is mostly coming from AR3354 in the northwest, but potentially also from AR3358 and AR3359 in the southeast.

Solar Wind / Geomagnetic Activity: A CME associated with the M3.8 flare from AR3354 on 29 Jun may include an Earth-directed component. Any glancing arrival at Earth would be expected early on day 1 (04 July), but it is considered more likely to miss. Solar winds are expected to be at ambient or slightly elevated levels through the period, with a slight enhancement possible from CH20/- on days 1 and 2 (04/05 July), although this is low confidence.

Geomagnetic activity is expected to be mostly Quiet to Unsettled throughout the period, with only a slight chance (10%) of Active or G1/Minor Storm conditions on day 1 (04 July) should we see any possible glancing CME impact or weak HSS. Another enhancement in geomagnetic

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

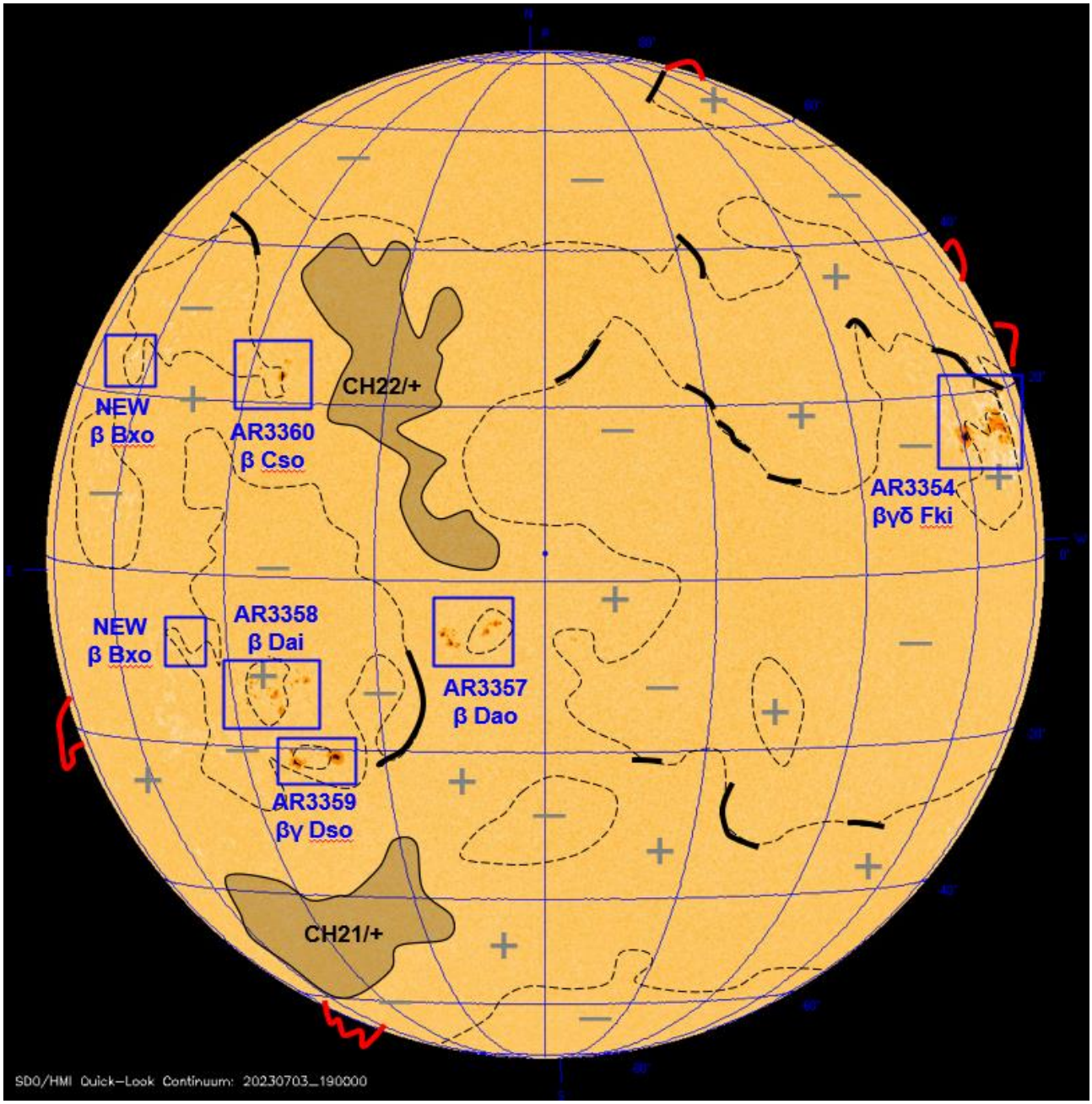
activity is likely on day 4 (07 July) as a high speed stream from CH22/+ arrives at Earth.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold throughout the period, as AR3354 (which produced an X1 flare on 02 July) produces any further significant flares as it continues to rotate closer to the northwest limb. High energy electron flux (greater than 2MeV) is expected to remain at diurnally high levels in the coming days, with a gradual reduction through the period in the absence of any geomagnetic activity. The corresponding fluence is above the Active (1e8 integrated flux) threshold and also expected to slowly decline.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 1. Solar Analysis Valid 04/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

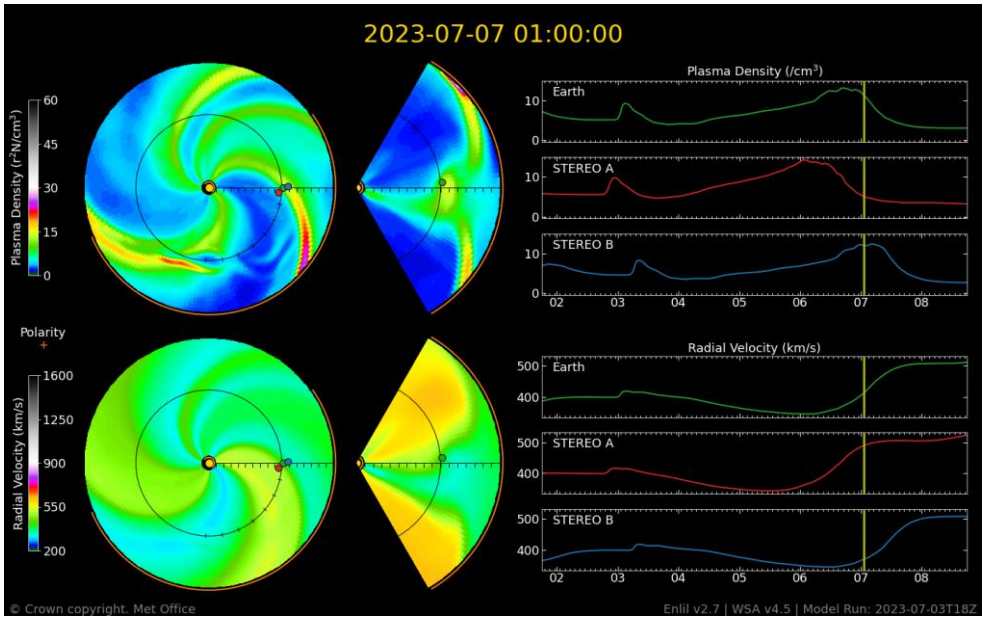
A CME associated with the M3.8 flare from AR3354 on 29 Jun may include an Earth-directed component, however most, if not all, of the ejecta appears directed above Earth. Any glancing arrival at Earth would be expected early on day 1 (04 July), but it is considered more likely to miss.

Solar wind speeds are now at ambient levels following the recent gradual decline from a slight enhancement from CH18/+. A connection to small CH20/- in the southwest may occur later on 04 July into the 05 July, however any enhancements from this are expected to be weak. A further connection to CH22/+ is likely on day 4 (07 July), with solar winds increasing to between 500 and 600km/s.

Geomagnetic activity is expected to be mostly Quiet to Unsettled throughout, with only a slight chance of Active or G1/Minor Storm conditions on day 1 (04 July) should we see any possible glancing CME impact or weak HSS. Geomagnetic activity may increase to Active with a slight chance of G1/Minor Storm by day 4 (07 July) due to the arrival of a fast wind from CH22/+.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL showing arrival of the next HSS from CH22 by 07 July.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

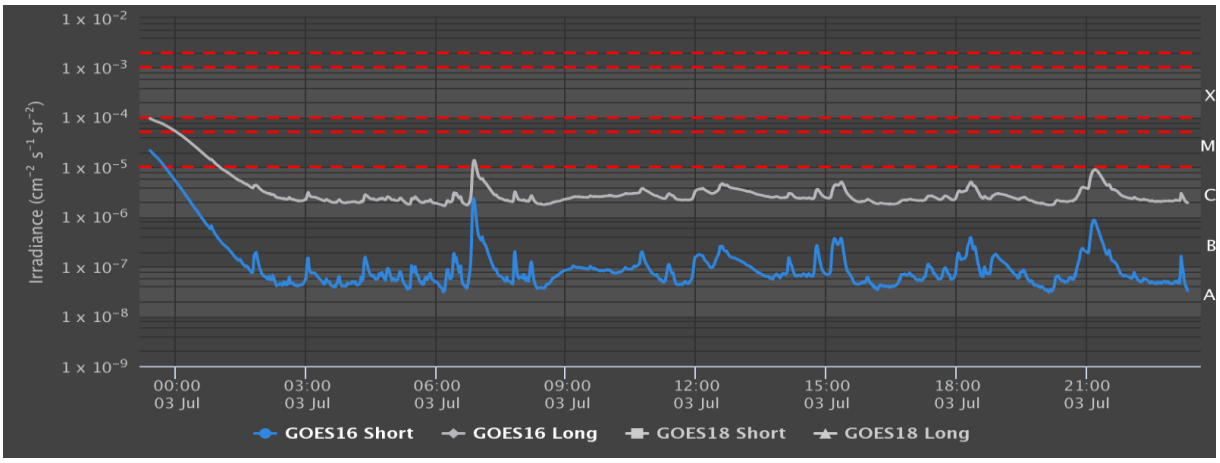
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate, with an M1.3 flare, peaking at 03/0653 UTC, originating from AR3358 in the southeast quadrant.

There are currently seven sunspot regions on the visible disc, five of which are numbered. AR3354 in the northwest remains the largest and most complex region. It still appears to contain a small and weak delta spot, although this is getting harder to assess as it starts to approach the limb. AR3359 in the southeast, previously contained a delta spot, but a reduction in penumbra means that it is now classified as a Dso/Beta-Gamma. AR3358 is close to AR3359 and is still showing signs of trying to develop a delta spot in its southern penumbral portion and will continue to be monitored. AR3360 in the northeast has produced numerous C-class flares. The remaining regions on the disc are relatively small or simple.

Low to Moderate solar activity is expected with a slight chance of further isolated X-class flares, most likely from AR3354. However, this region rotates off the disc during 05 July, leading to a declining risk of flares during 05-06 July. As such the flare risk reduces during the period, but this may be revised should additional sunspots develop or active regions emerge over the east limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	50	40	30
Very Active	R3 to R5 X Class	No	15	10	10	5

Figure 3: GOES-16 X-ray flares.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a slight chance of S1/Minor storm levels being reached throughout the period. This is mainly due to AR3354, given its favourable location in the western hemisphere. Although AR3354 rotates off during 05 July, the risk of radiation storms remains until it is well over the limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	15	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been diurnally fluctuation between Moderate and High levels. It is likely to continue this pattern over the coming days, in the absence of any notable geomagnetic activity, although it is likely that there will be a gradual decline in flux levels at GEO through the period. There is a slight chance of a CME arrival on the 04 July and a weak HSS which could give a sharper decrease in flux levels, but these features are low confidence and it is more likely that there will be little effect from them.

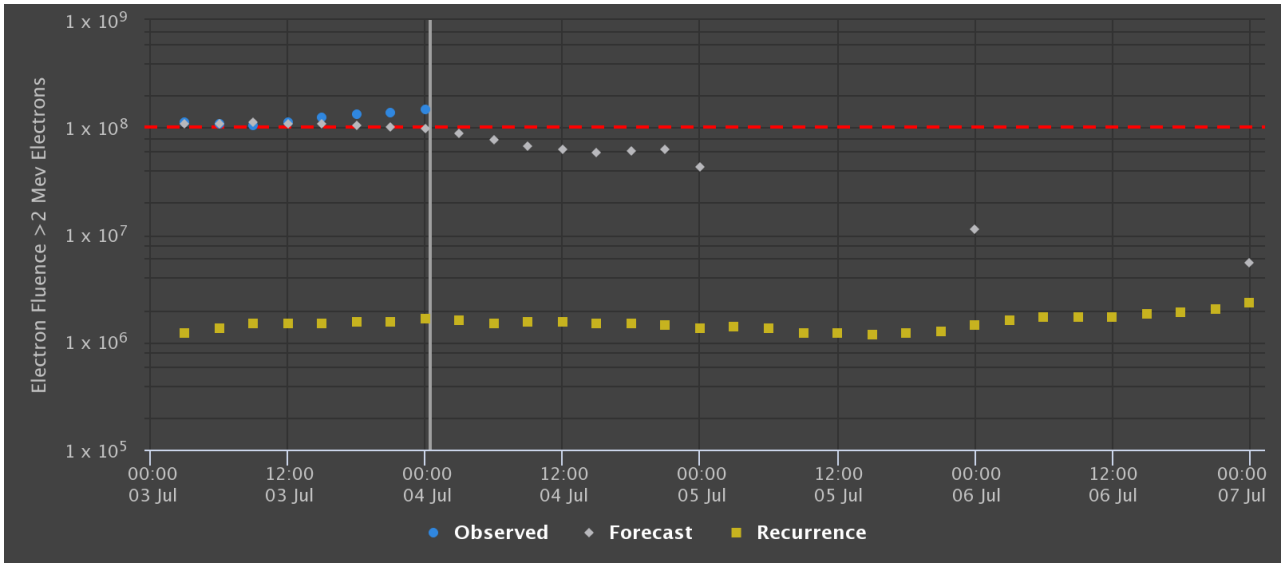
Electron fluence is expected to start above the Active threshold (>1e8 integrated pfu), probably with a slow decline, although confidence is low in the exact timing of any decrease below Active. MOSWOC REFM is also suggesting a slow decline below Active, which is a reasonable trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 4: REFM electron fluence – observations, forecast and recurrance.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.